Automating Internet Distribution with Script-Driven Provisioning and Load Balancing Methods

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Abstract

The utilization of software-based automation technology in the internet network distribution process is currently relatively expensive, while conventional configuration methods cause inefficient use of time, cost, and energy. The time spent is about 5 minutes for each configuration process. The waiting time for a queue of 5 customers with 1 technician is 20 minutes. This problem can be solved by applying the concept of network automation using the Zero Touch Provisioning method, which can increase time efficiency to 5 seconds for each configuration process. Additionally, the use of Priority and Round-Robin algorithms is very helpful in overcoming queue management problems, allowing the server to work according to the desired process logic. The results showed an average wait time of 7.6 seconds with a quantum value of 10. This value was obtained in the process of 5 customer queues with 1 server.

Keywords *— Automation, Provisioning, Priority, Round-Robin, ZTP*

1. INTRODUCTION

The increasing demand for Internet services is compelling Internet Service Providers (ISPs) to enhance efficiency across all operational aspects. Effective management of Internet network distribution plays a pivotal role in this domain, enabling companies to streamline processes in terms of time, energy, and costs through efficient management practices.

Network automation is a framework designed to automate specific tasks by interpreting, understanding, and implementing logical processes. It aims to enhance the capabilities of manual tasks while reducing error rates and enhancing scalability with minimal effort. In simpler terms, network automation automates the configuration, management, and operation of computer networks [1].

Zero Touch Provisioning (ZTP) simplifies the automation of network device configuration processes. It enables the provisioning, management, and testing of network devices, significantly improving efficiency compared to manual configuration methods. ZTP also automates repetitive tasks such as configuration backup and monitoring [2].

Despite the high costs associated with adopting software-based automation technologies for device configuration, manual configuration processes by technicians remain prevalent. An economically viable alternative involves using Script-Driven automation technology, particularly through the implementation of the ZTP method in network automation systems. This approach leverages ZTP to achieve high performance and address substantial data requirements [3]. Additionally, the utilization of Priority and Round-Robin algorithms enhances queue management for improved configuration processes.

2. RESEARCH METHOD

The research method used in this study is action research. Action research emphasizes activities (actions) by testing an idea in practice or real situations on a micro-scale which are expected to be able to improve, improve quality, and make social improvements [4].

The action research method can make research and development (R&D) more effective and efficient [5]. In addition, action research can be said to have the aim of developing new skills or new approaches and solving problems with direct application in the world of work. From this understanding and purpose, the author feels suitable to use action research methods to support the achievement of the author's goals.

Broadly speaking, the steps in this action research include planning, acting, monitoring, and reflecting. The four steps can be seen in Figure 1 below:

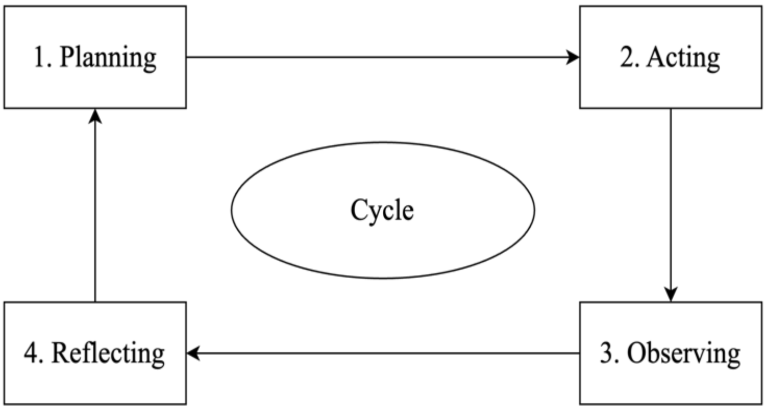

Figure 1. Action Research Flow

1. Planning, in this process the research begins by defining the problem formulations and objectives of the research so that the direction and objectives of the research become clearer. After that, collect the data needed to be able to carry out research which will then produce theories and knowledge related to the needs to be prepared, both software and hardware.
2. Acting, the implementation process is the stage for implementing what has been planned previously.
3. Observing, after the research is carried out and obtained results, observation activities are carried out to obtain data that shows the weaknesses or shortcomings of the research.
4. Reflecting, is an assessment process by summarizing the results of observations. Until this stage, if the results of the reflection still do not show satisfaction with the achievement of the objectives of the research, the action research process cycle can continue to be repeated until it achieves the desired goals.

The type of data used in this research is qualitative data. This type of qualitative data is usually descriptive and informative about what criteria are needed to be able to design a new network distribution infrastructure according to the objectives of the research. The data sources in this research consist of primary and secondary data. These data are obtained by several data collection methods, namely interviews, literature studies, and field studies [6].

The network infrastructure model design method provides a structured concept of rules, activities, and procedures in designing network models and infrastructure. In this study, the authors used the Network Development Life Cycle (NDLC) method as a method of creating a suitable model for designing and developing network infrastructure [7].

There are several adjustments to the NDLC method to make it more relevant to the research to be carried out. The method acts as a reference and framework in the design process of the network infrastructure model. Figure 2 shows the flow chart of the NDLC method as a whole before and after being adjusted to the circumstances of the research to be carried out.

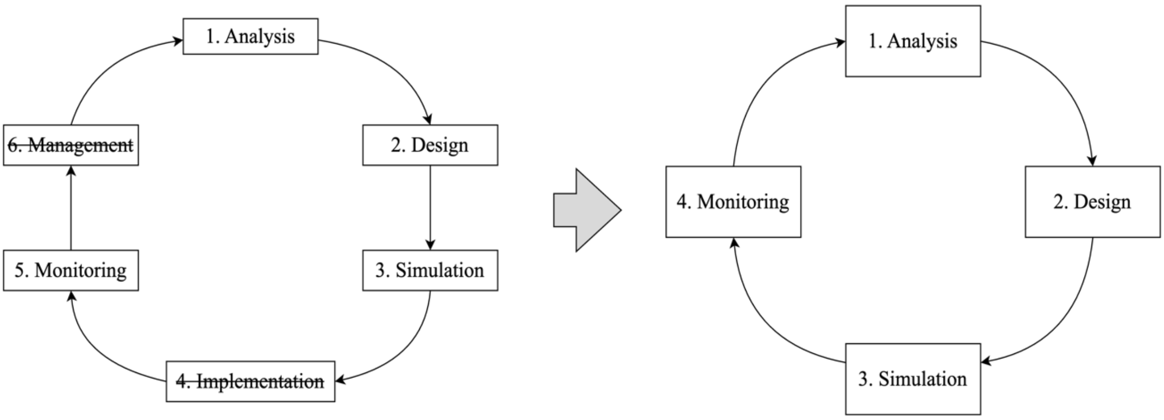

Figure 2. NDLC Cycle

In Figure 2, it can be seen that the "Implementation" and "Management" processes are not included in the method steps in this study. This is because this research does not discuss the implementation process of the model that has been made to the field, the model trial is carried out virtually with conditions close to the situation in the field. Because the implementation process is not carried out, there is no management process in this research.

1. Analysis, the process of designing the system as a result of analyzing the data that has been collected previously.
2. Design, design software and hardware infrastructure and produce prototypes that provide the scope and limits of the research.
3. Simulation, system trials based on the design and design that has been made with the virtualization method in a scenario that is close to the actual situation in the field.
4. Monitoring, data results from simulations are analyzed and system improvements are made if necessary until they are in accordance with the objectives to be achieved.

3. RESEARCH RESULTS AND DISCUSSION

3.1. Network Model Design

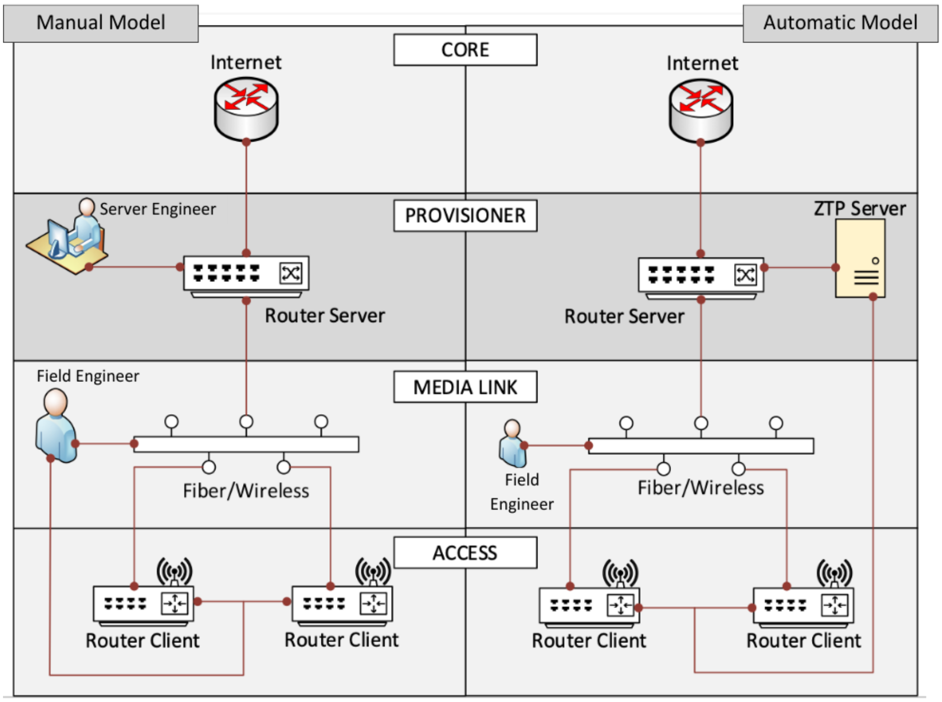

Figure 3. Manual and Automated Network Model Design

In the new network model, the interaction between technicians and firmware devices will be completely replaced by the ZTP Server. The technician is only in charge of monitoring and physical installation to the customer's home.

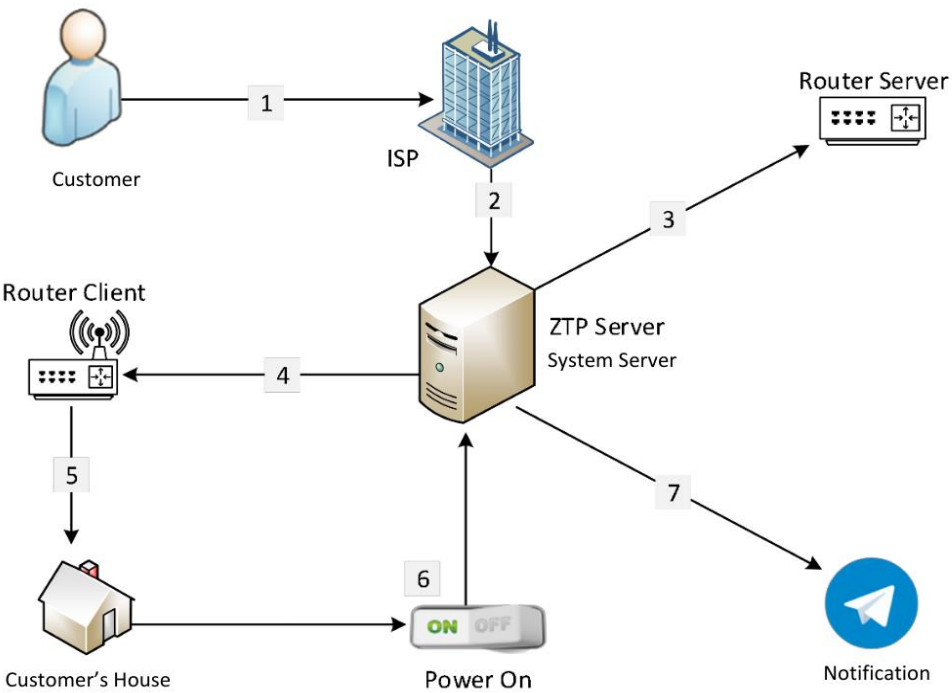

Figure 4. Network Installation Process Flow

This model is a form of application of the Zero Touch Provisioning method where the process is fully automated by the system. The ZTP method aims to reduce operational costs by reducing human involvement in performing network device configuration tasks [8].

3.2. Input and Logic Process

Table 1. Input Spesification

Categories	Description
Input Type	*API Request*
Number of Process Queues / Request	1 process queue
Number of Job / Process	2 *jobs*
Average Execution Time / Process	4,2 seconds
Number of Threads	1 lane/channel

Process logic describes how the rules for treating inputs (process queue).

1. The earliest arriving queue with the lowest priority value must be served first.
2. Each queue has an execution time threshold that will be determined as needed.
3. Each queue must complete 2 jobs where as long as the job process is running, other queues cannot interrupt until the job process is complete.

Table 2. Process Details

Job Number	Job Name	Task List
1	Configuration	▪ Queue validation ▪ Retrieve configuration data ▪ Connect to router ▪ Send configuration data and update database
2	Notification	▪ Queue validation ▪ Retrieve customer data ▪ Send message via Telegram and update database

The flowchart of system describes how the system algorithm works starting from input, process to output. The flowchart is a graphic depiction of the steps and sequence of procedures of a program [9].

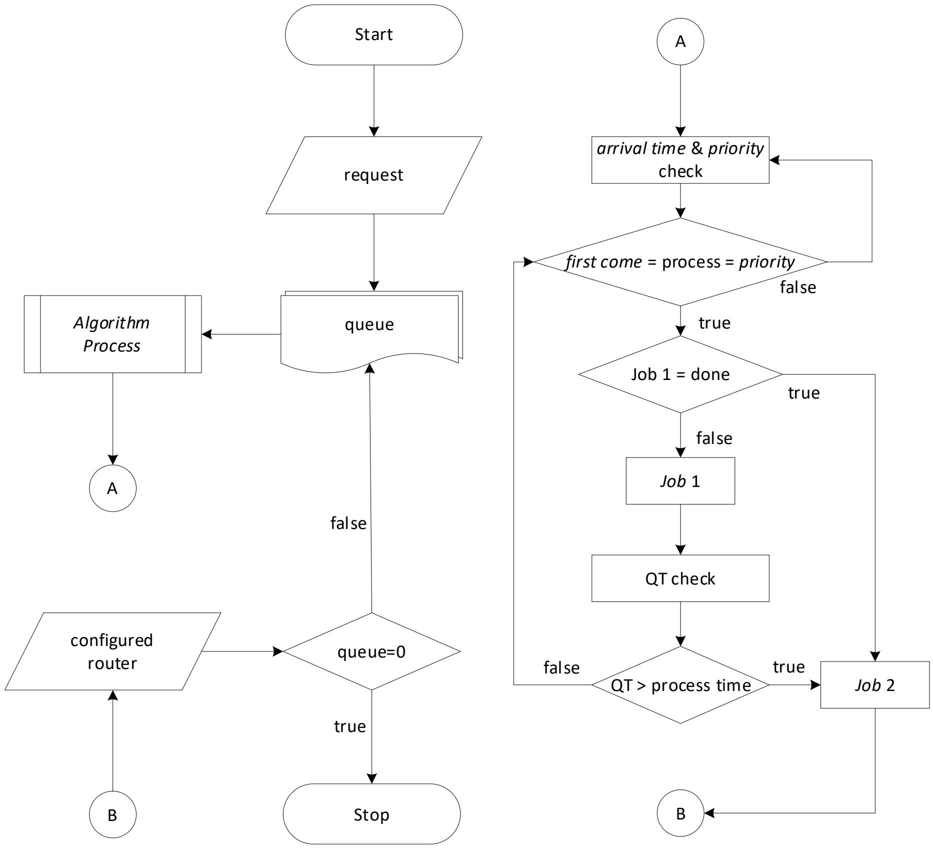

Figure 5. Flowchart of the System

The process of checking the final value of quantum with processing time only occurs every time a Job is completed. If the processing time is still smaller than the quantum time then the process continues to the next Job, while if not then check the priority status again, if it is still a priority then continue the process to the next Job.

The Round-Robin algorithm is adjusted to the process logic that you want to create. In Round-Robin, the process that reaches the quantum time is temporarily stopped and moved to the back of the queue [10], while in this study, the queue that reaches the quantum time is checked for priority status again then if it is still in the top priority the queue continues to the next process. This research uses a combination of the First Come First Serve (FCFS), Priority, and Round-Robin algorithms with some adjustments.

3.3. Result

The queue data to be simulated in this study amounted to 5 queues with different parameters and can be seen in Table 3.

Table 3. Configuration Request

Order	Process	Prioritization	Arrival Time	Job 1 Ex.Time	Job 2 Ex.Time
1	1	3	0	4	1
2	2	2	1	3	1
3	3	1	1	3	1
4	4	3	2	4	1
5	5	2	2	3	1

The results after being processed using the ZTP server there are differences in the treatment of queues in Table 4.

Table 4. Sorted Queue Data

Order	Process	Prioritization	*Arrival Time*	*Job* 1 *Ex.Time*	*Job* 2 *Ex.Time*
1	1	3	0	4	1
2	3	1	1	3	1
3	2	2	1	3	1
4	5	2	2	3	1
5	4	3	2	4	1

After the initial data is sorted, the process continues with modeling the process using a Gantt Chart to facilitate the wait time calculation process.

Table 5. Gantt Chart (Quantum = 1)

P1	**P3**	**P3**	**P2**	**P2**	**P5**	**P5**	**P1**	**P4**	**P4**
Job 1	Job 1	Job 2	Job 1	Job 2	Job 1	Job 2	Job 2	Job 1	Job 2

0 4 7 8 11 12 15 16 17 21 22

The results of the total waiting time calculation can be seen in Table 5 with the average wait time value for Quantum = 1 is 9.4 seconds.

Table6. Waiting Time (Quantum = 1)

Process	Waiting Time Service Time – Arrival Time
1	(0 - 0) + (16 - 4) = 12
2	(8 - 1) + (11 - 11) = 7
3	(4 - 1) + (7 - 7) = 3
4	(17 - 2) + (21 - 21) = 15
5	(12 - 2) + (15 - 15) = 10
Average Wait Time = (12+7+3+15+10) / 5 = 9,4	

Furthermore, a re-simulation is carried out with a quantum value = 5 to get the fastest average waiting time value.

Table 7. Gantt Chart (Quantum = 5)

P1	**P1**	**P3**	**P3**	**P2**	**P2**	**P5**	**P5**	**P4**	**P4**
Job 1	Job 2	Job 1	Job 2	Job 1	Job 2	Job 1	Job 2	Job 1	Job 2

0 4 5 8 9 12 13 16 17 21 22

Average wait time using the value of Quantum = 5 shows better results of 7.6 seconds which is 1.8 seconds faster than the average wait time using the value of Quantum = 1. This is because the process of working on Job 1 and Job 2 is carried out in 1 runtime process without any interrupt so that there is no queue of delayed processes.

Table 8. Waiting Time (Quantum = 5)

Process	Waiting Time Service Time – Arrival Time
1	(0 - 0) + (4 - 4) = 0
2	(9 - 1) + (12 - 12) = 8
3	(5 - 1) + (8 - 8) = 4
4	(17 - 2) + (21 - 21) = 15
5	(13 - 2) + (16 - 16) = 11
Average Wait Time = (0+8+4+15+11) / 5 = 7,6	

The use of Quantum value 10 should have the same results as Quantum 5 because the Gantt Chart implementation results show the same data.

Table 9. Gantt Chart (Quantum = 10)

P1	P1	P3	P3	P2	P2	P5	P5	P4	P4
Job 1	Job 2	Job 1	Job 2	Job 1	Job 2	Job 1	Job 2	Job 1	Job 2

0 0 4 5 8 9 12 13 16 17 21

Average wait time using Quantum value = 10 shows the same results as average wait time using Quantum value = 5.

Table 10. Waiting Time (Quantum = 10)

Process	Waiting Time Service Time – Arrival Time
1	(0 - 0) + (4 - 4) = 0
2	(9 - 1) + (12 - 12) = 8
3	(5 - 1) + (8 - 8) = 4
4	(17 - 2) + (21 - 21) = 15
5	(13 - 2) + (16 - 16) = 11
Average Waiting Time = (0+8+4+15+11) / 5 = 7,6	

From the results of the program implementation, it is obtained that the use of quantum values 5 and 10 gives the best average wating time results compared to quantum time value 1. This is because the quantum time value that is smaller than the processing time of each job will cause changes in the queue order so that the resulting waiting time becomes larger. The use of Quantum value 10 is more recommended to prevent interrupt Job that has execution time greater than 5.

4. CONCLUSION

The application of the Zero Touch Provisioning concept has brought significant improvements in operational efficiency, the configuration process runs very fast at about 5 seconds per process, reduces costs by replacing human work with automation, and avoids human error. The use of a combination of Priority and Round-Robin algorithms in queue management has proven accurate in performing queue management according to the desired process logic. In addition, simulating a configuration with 5 queues and 1 server results in an average waiting time of about 7.6 seconds, with the use of quantum values of 5 and 10 to run Job 1 and Job 2 in the same process runtime.

5. SUGGESTED

The author through this research has provided a basic concept for building an ISP network that is very possible to be developed further. Large-scale implementation can utilize multiple ZTP servers per region or per province to be able to cope with the load of the number of configurations of the new customer configuration process.

The utilization of SSL security protocol is also a good step to be able to improve this research to be better in terms of security. The SSL protocol implemented on the API server endpoint will make security against internet network hijacking more secure.

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